# Service Manual

FILE No.

Ultra-Low Temp. Freezer

**MDF-394**

**MDF-393(N)**

SANYO Electric Co., Ltd.
Biomedical Business Division

**RoHS**

This product does not contain any hazardous substances prohibited by the RoHS Directive.
(You will find 'RSF' mark near the rating plate on the RoHS compliant product.)

**WARNING**

* You are requested to use RoHS compliant parts for maintenance or repair.
* You are requested to use lead-free solder.

SM9910175

## Effective models

This service manual is effective following models.

| Model name | Product code | Voltage and Frequency | |
|---|---|---|---|
| MDF-394 | 823 013 52 | 220V | 50Hz |
| | 823 013 54 | 220/230/240V | 50Hz |
| MDF-393(N) | 823 013 56 | 220V | 50Hz |

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# Specifications

■Structural specifications

| Item | MDF-394/393(N) |
|---|---|
| Name | Ultra-Low Temperature Freezer |
| External dimensions | W1860 × D800 × H945 (mm) |
| Internal dimensions | W1120 × D520 × H530 (mm) |
| Effective capacity | 309 L |
| Outer door | Painted steel |
| Inner door | 3 pcs |
| Insulation | Rigid polyurethane foamed-in place |
| Exterior | Painted steel |
| Interior | Stainless steel |
| Outer door latch | 1 pc |
| Outer door lock | 1 pc |
| Access port | 1 place (left side)  inner diameter; φ40mm |
| Refrigeration circuit | Secondary cooling system |
| Compressor | High stage side; Hermetic type, Output; 450W<br>Low stage side; Hermetic type, Output; 750W |
| Evaporator | Tube on sheet type |
| Condenser | High stage side; Fin and tube type<br>Low stage side; Shell and tube type |
| Refrigerant | High stage side; R-404A<br>Low stage side; R-508 |
| Refrigerant oil | Ze-NIUSL22SA |
| Power supply | Local voltage |
| Battery | Nickel-metal-hydride battery, DC 6V, 1100mAh, Auto recharge |
| Weight | 219 Kg |
| Accessories | 1 set of key, 1 scraper |
| Optional component | Aluminum container (MDF-39SC)<br>Storage rack (IR-209C, IR-306C) |

■Control specifications

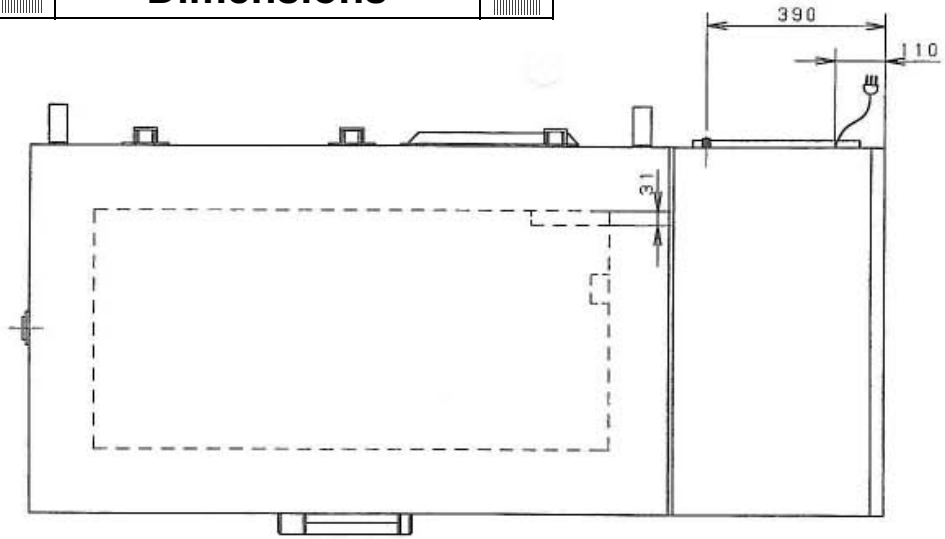
| Item | | MDF-394/393(N) |
|---|---|---|
| Temp. controller | | Microcomputer control system<br>Temperature setting range: -50C～-90C (Unit: 1C)<br>Non-volatile memory |
| Thermal sensor | | Pt.1000Ω |
| Temperature display | | LED digital display |
| Alarms | High temp. | +5C~+20C for High temperature alarm (Initial; +10C)<br>ALARM lamp blinks and buzzer sounds intermittently with 15min. delay<br>Remote alarm contact; Normal Open, Normal Close<br>Allowable contact capacity; Max. 30VDC, 2A |
| | Low temp. | -5C~-20C for Low temperature alarm (Initial; -10C)<br>ALARM lamp blinks and buzzer sounds intermittently with 15min. delay<br>Remote alarm contact; Normal Open, Normal Close<br>Allowable contact capacity; Max. 30VDC, 2A |
| | Filter check | FILTER lamp blinks and buzzer sounds intermittently |
| | Power failure | ALARM lamp blinks, buzzer sounds intermittently and remote alarm is output. |
| | Remote alarm | Remote alarm terminal 3P; DC30V、2A<br>NC-COM, NO-COM |
| | Battery lifespan | 'F1' and PV are displayed alternately when battery accumulation time is about 3 yrs |
| | Fan motor lifespan | 'F2' and PV are displayed alternately when fan motor accumulation time is about 6 yrs |
| Control panel | | Lamps: ALARM, FILTER CHECK<br>Buzzer key: BUZZER<br>Alarm test key: ALARM TEST<br>Set key: SET<br>Digit shift key: ⏩<br>Numerical value shift key: ⏫ |
| Self diagnosis | | When any failure is occurred in sensor among temp. sensor, filter sensor, cascade sensor and AT sensor;<br>● Error code and chamber temperature are displayed alternately<br>● ALARM lamp blinks<br>● Remote alarm activates<br>● Buzzer sounds intermittently |
| Alarm resume time | | The buzzer will be activated again after certain suspension if the alarm condition is continued. (Initial; 30 minutes) |
| Compressor protection | | When the cascade sensor temperature is lower than -34C, L side compressor is turned on.<br>When the cascade sensor temperature is higher than -18C, L side compressor is turned off.<br>When the filter sensor is higher than +60C, High side compressor is turned off.<br>Overload relay for L side compressor, Internal thermometer for High side compressor |

■Performance specifications

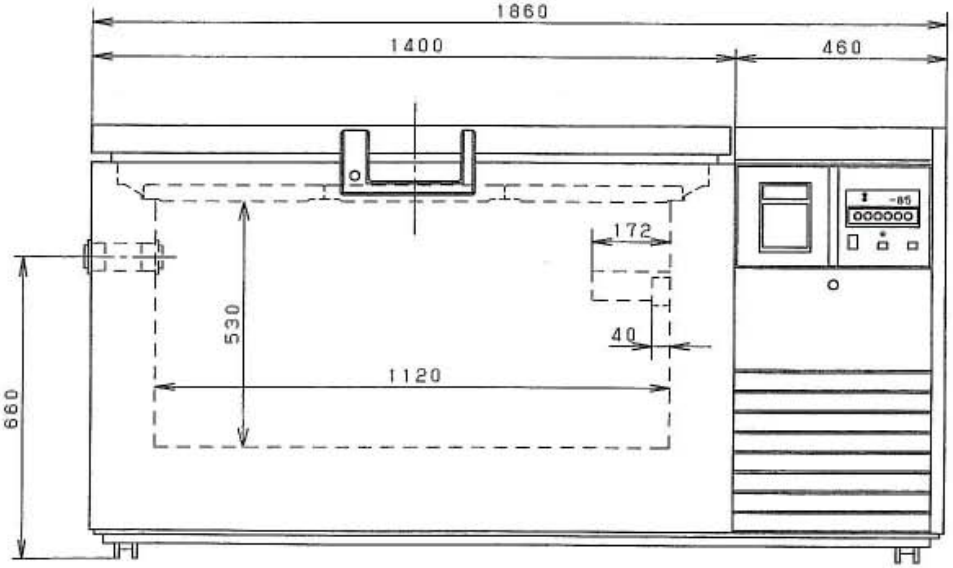
| | | | |
|---|---|---|---|
| Cooling performance | -86C at the center of the chamber (AT30C, no load) | | |
| Temperature control range | -50C～-86C（AT30C, no load） | | |
| Power source | 220V, 50Hz | 230V, 50Hz | 240V, 50Hz |
| Rated power consumption | 620 W | 650 W | 680W |
| Noise level | 49 dB {A} (background noise 20dB) | | |
| Maximum pressure | 1.73 MPa | | |

* Design or specifications will be subject to change without notice.

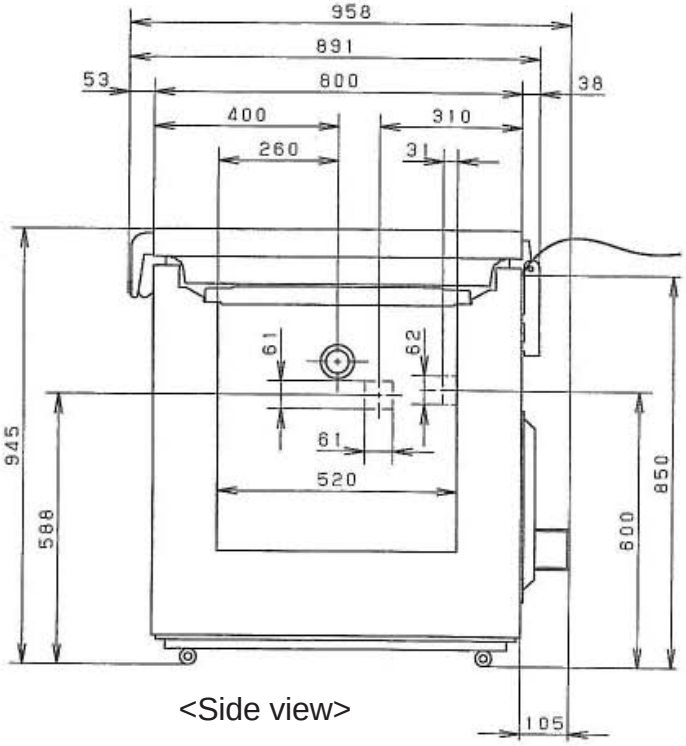
# Dimensions




<Over view>




<Front view>




<Side view>

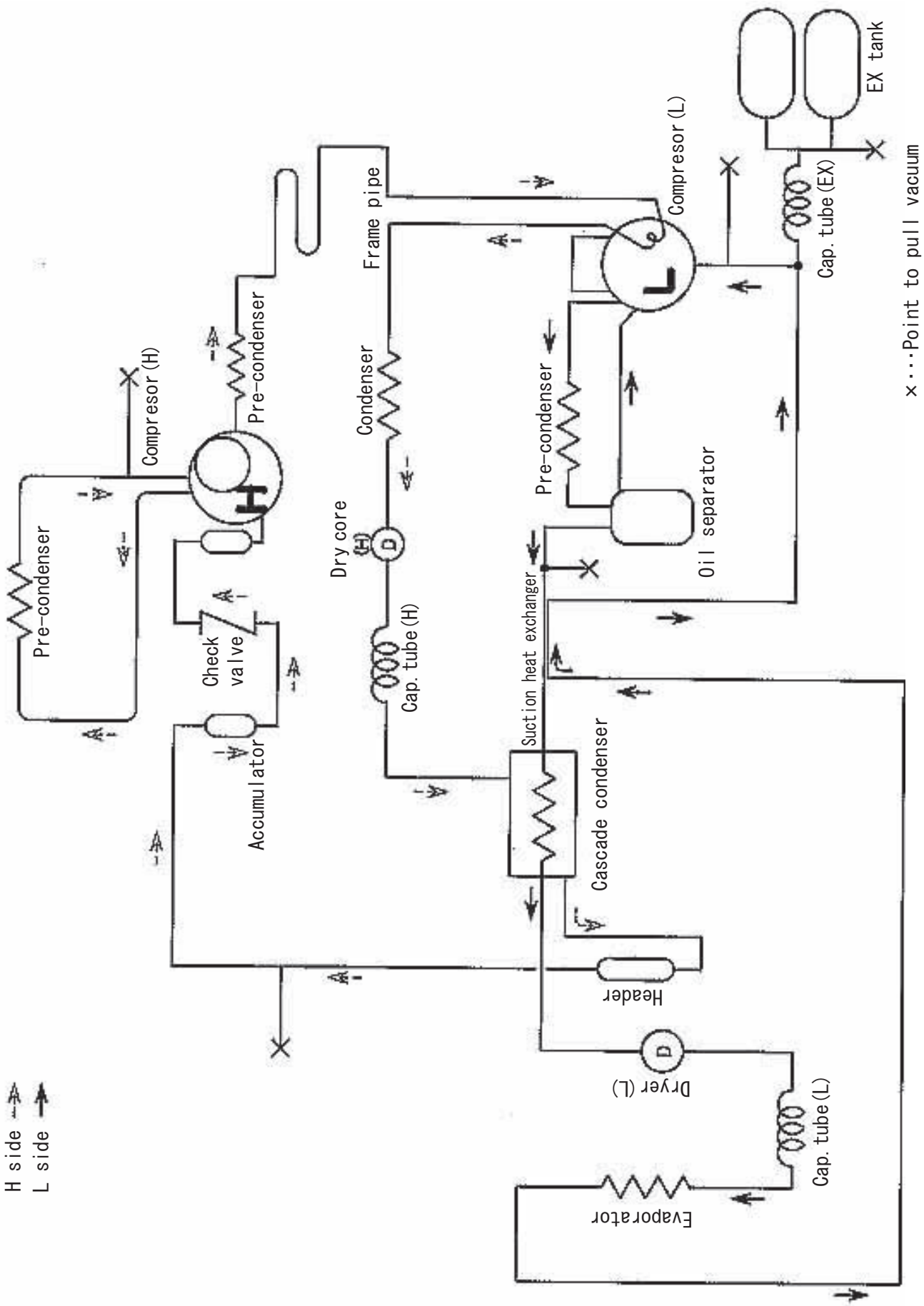
# Cooling unit parts

**<MDF-394/393(N)>**

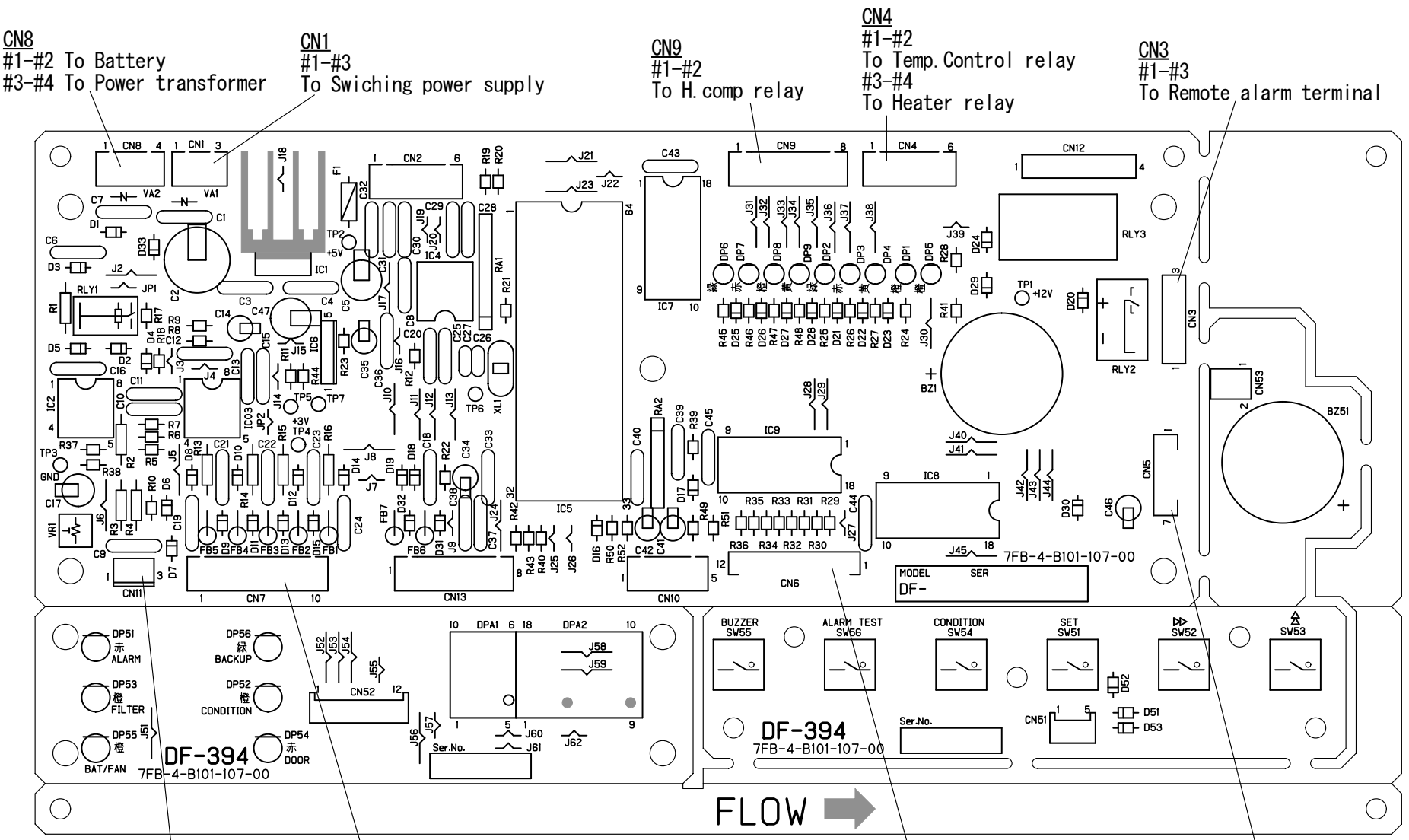
| Item | Specifications | | |
|---|---|---|---|
| | H side | L side | |
| **Compressor** | | | |
| 220V,60Hz | Type:C-1RN45L6A<br>Code:802 021 16 | Type:CS200J1NS-7A<br>Code:7FB-0-M101-002-06 | |
| 220V,50Hz | Type:C-1RN45L5A<br>Code:812 022 15 | Type:CS200J1NS-4A<br>Code:7FB-0-M101-002-04 | |
| 230/240V,50Hz | Type:C-1RN45L5A<br>Code:812 022 15 | Type:KS200J1NS-4A1<br>Code:7FB-0-M101-002-05 | |
| Refrigerant oil | Ze-NIUSL22SA<br>Charged q'ty: 230cc | Ze-NIUSL22SA<br>Charged q'ty: 850cc | |
| Cooling system | Forced air cooling（partially）<br>DSH | Forced air cooling（partially）<br>Oil cooler | |
| **Condenser** | | | |
| Type | Fin and tube | Cascade condenser | |
| Condenser | 12 columns x 3 lines P6.35mm<br>Fin 38pcs. | Coil pipe $\phi$6.35mm | |
| Pre-condenser | W 250mm | —— | |
| Frame pipe | $\phi$6.35mm | —— | |
| **Evaporator**<br>Type | Cascade condenser<br>Shell and tube $\phi$80mm | Tube on sheet<br>$\phi$7.94mm | |
| **Capillary tube** | | | Ex. capillary |
| Resistance<br>PSI・kg/cm$^2$ | 94 PSI/G | 0.363MPa | 34 PSI/G |
| Length | 1800mm | 3000mm | 500mm |
| Outer diameter | $\phi$2.0mm | $\phi$2.0mm | $\phi$2.4mm |
| Inner diameter | $\phi$1.0mm | ($\phi$0.9mm) | $\phi$1.2mm |
| **Refrigerant** | R-404A+4pt Charged q'ty: 331g | R-508 Charged q'ty: 230g | |
| **Oil additive** | n-Pentane<br>Charged-q'ty: 14g | n-Pentane<br>Charged q'ty: 33g | |
| **Dryer** | 4AXH-9 (For production in Dec.'08 or before)<br>Dry core (For production in Jan.'09 or later) | 4AXH-9 Charged q'ty: 58g | |
| **Condensing fan** | $\phi$230 mm、4 blades<br>Material: ABS Output:11W | | |
| **Condensing fan motor** Type | SE4-E11L5P | | |
| **Oil separator** | —— | SPK-0S02S2 | |

* Please use 'Dry core' for servicing.

# Refrigeration Circuit



# Components on PCB

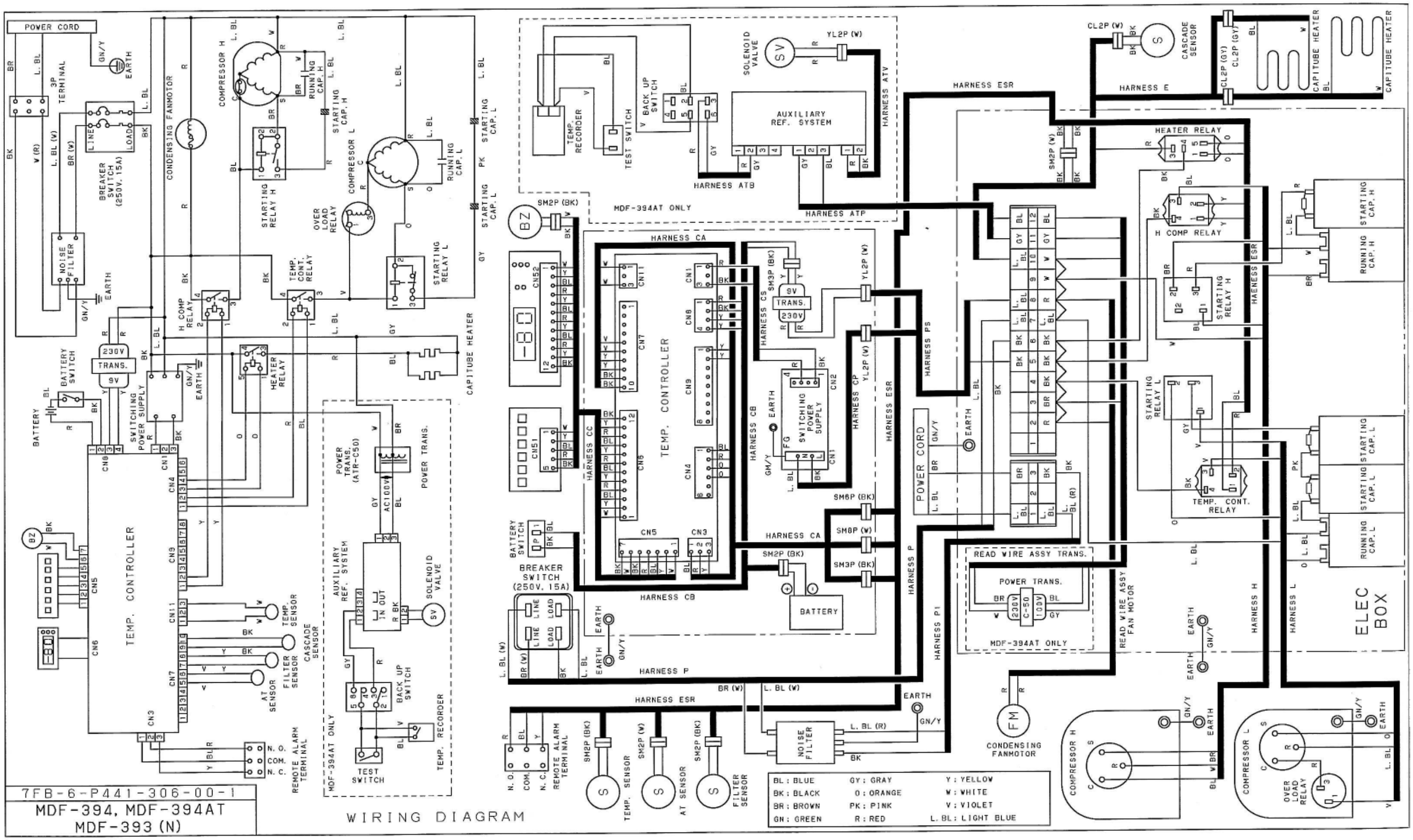


# Connection on PCB

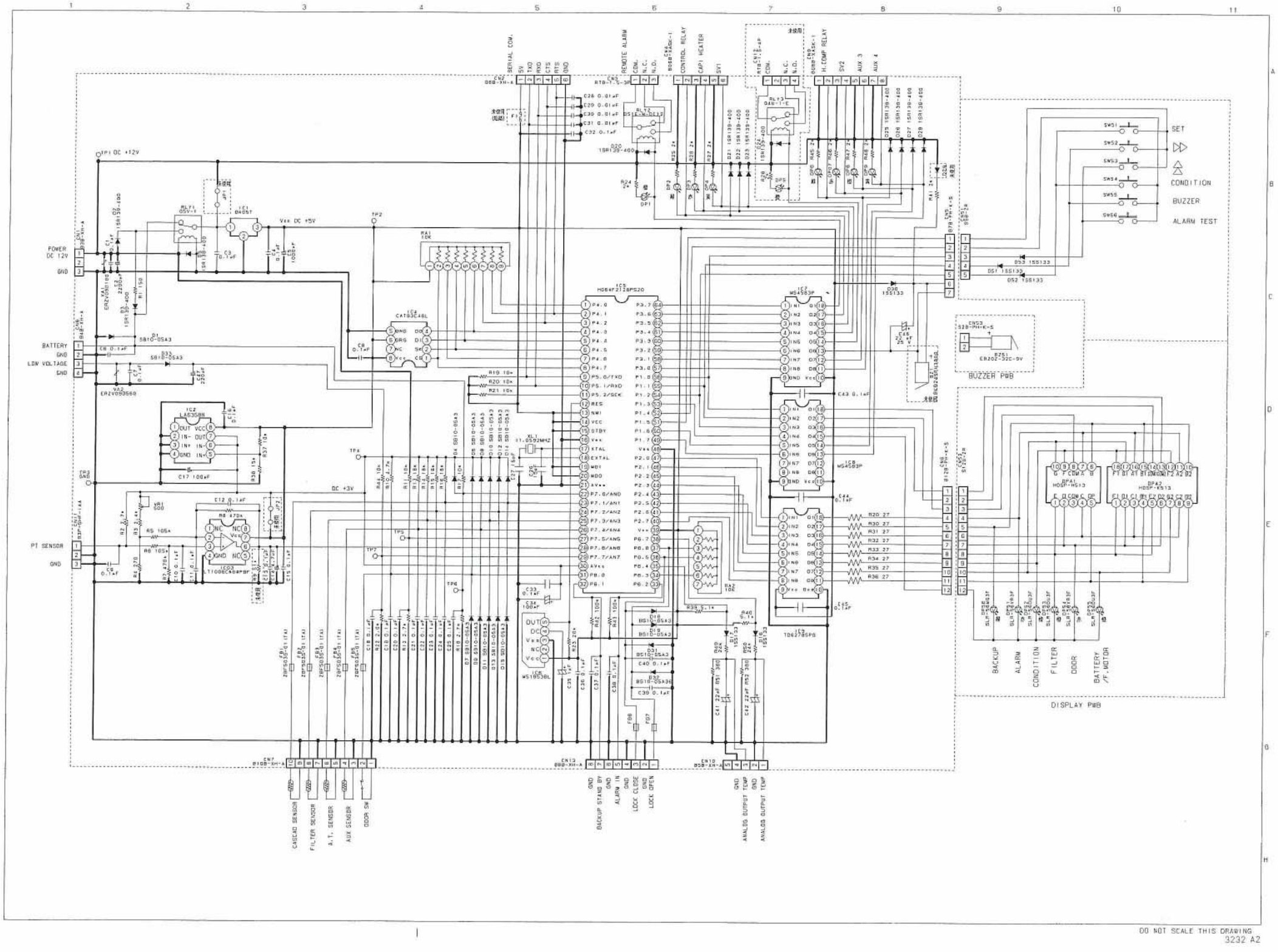
The following shows connections of connector on Temp. Control PCB.

| Connector | Connects to | Usage | Voltage |
|---|---|---|---|
| CN1 | #1 - #3: Switching power supply | To supply the power to PCB. | #1-#3: 12VDC |
| CN3 | Remote alarm terminal<br>#1: Com<br>#2: N.O.<br>#3: N.C. | Output of remote alarm contact<br>● Between #1 - #2 is open if the unit has no alarm condition when the power is supplied.<br>● Between #1 - #3 is closed. | |
| CN4 | #1 - #2: Temp. control relay<br>#3 - #4: Heater relay | To operate compressor L.<br>To operate cap. tube heater. | #1 - #2: 12VDC<br>#3 - #4: 12VDC |
| CN5 | #1 - #5: Switch PCB<br>#6 - #7: Buzzer PCB | To connect with each switch.<br>To energize buzzer. | |
| CN6 | Display PCB | To connect with each LED. | |
| CN7 | #5 - #6: AT sensor<br>#7 - #8: Filter sensor<br>#9 – #10: Cascade sensor | To detect ambient temperature.<br>To detect temperature on the outlet pipe of condenser.<br>To detect cascade temperature. | |
| CN8 | #1 - #2: Battery<br>#3 – #4: Power transformer | Power failure alarm. | #1: 6VDC<br>#2: GND |
| CN9 | #1 - #2: H comp. relay | To operate compressor H | #1 - #2: 12VDC |
| CN11 | #1 - #3: Temp. sensor | To detect chamber temperature | |

# Wiring Diagram



## Circuit Diagram



# Electric Parts

| MDF-394/393(N) | | AC220V, 50Hz | AC230/240V,50Hz |
|---|---|---|---|
| Compressor (H) | Type | C-1RN45L5A | C-1RN45L5A |
| | Code | 803 021 15 | 803 021 15 |
| | Rated voltage (50/60Hz) | $\phi$1, 220V, 50Hz | $\phi$1, 220V, 50Hz |
| | Winding resistance C-R(Main) | 5.95Ω | 5.95Ω |
| | C-S(Aux) | 14.76Ω | 14.76Ω |
| Starting relay (H) | Type | AMVL-300A | AMVL-300A |
| | Pick up voltage | 185~217VAC | 185~217VAC |
| | Drop out voltage | 60~120VAC | 60~120VAC |
| Starting capacitor (H) | Rating | 40$\mu$F, 300V | 40$\mu$F, 300V |
| Running capacitor (H) | Rating | 12$\mu$F, 370V | 12$\mu$F, 370V |
| Condensing fan motor | Type | SE4-E11L5P | SE4-E11L5P |
| | Rating | 220~240V, 11W | 220~240V, 11W |
| Compressor (L) | Type | CS200J1NS-4A | CS200J1NS-4A1 |
| | Code | 7FB-0-M101-002-04 | 7FB-0-M101-002-05 |
| | Rated voltage (50/60Hz) | $\phi$1, 220V, 50Hz | 230/240V, 50Hz |
| | Winding resistance C-S(Aux) | 4.6Ω | 4.7Ω |
| | C-R(Main) | 2.1Ω | 2.7Ω |
| Starting relay (L) | Type | AMVL-300TA | AMVL-300TA |
| | Pick up voltage | 205~235VAC | 205~235VAC |
| | Drop out voltage | 110VAC | 110VAC |
| Overload relay (L) | Type | MRA99954-9201 | MST16AJ120/61-9201 |
| | Action to the temp. (No current) | | |
| | OFF | 135+/-5℃ | 120+/-5℃ |
| | ON | 69+/-11℃ | 61+/-11℃ |
| | Action to the current (AT25℃) | 29.5A | 20.5A |
| | Operation time | 6~16sec | 6~16sec |
| Starting capacitor (L) | Rating | 160$\mu$F, 250Vx2 | 160$\mu$F, 250V |
| Running capacitor (L) | Rating | 15$\mu$F, 400V | 15$\mu$F, 400V |
| Cap.tube heater | Rating | 230VAC 12W | 230VAC 12W |
| | Resistance (AT25℃) | 4.7KΩ | 4.7KΩ |
| Temp. control relay | Type | G4F-11123T | G4F-11123T |
| | Contact capacity | 20A, 250VAC | 20A, 250VAC |
| | Coil | DC12V | DC12V |
| H. comp. relay | Type | G4F-11123T | G4F-11123T |
| | Contact capacity | 20A, 250VAC | 20A, 250VAC |
| | Coil | DC12V | DC12V |
| Heater relay | Type | G2R-1A-T | G2R-1A-T |
| | Contact capacity | 10A, 250V | 10A, 250V |
| | Coil | DC12V | DC12V |
| Temperature sensor | Type | 1000Ω | 1000Ω |
| | Rating | THC-710 | THC-710 |
| Cascade sensor | Type | 502AT-1 | 502AT-1 |
| | Rating | 5KΩ, 25℃ | 5KΩ, 25℃ |
| Filter sensor | Type | 502AT-1 | 502AT-1 |
| | Rating | 5KΩ, 25℃ | 5KΩ, 25℃ |
| AT sensor | Type | 502AT-1 | 502AT-1 |
| | Rating | 5KΩ, 25℃ | 5KΩ, 25℃ |
| Power transformer | Type | S41-RN97PV | S41-RN97PV |
| | Primary | 115V | 115V |
| | Secondary | 230V | 230V |
| Battery | Type | 5HR-AAC | 5HR-AAC |
| | Rating | 6V, 1100MAH | 6V, 1100MAH |
| Battery switch | Type | SLE6A2-5 | SLE6A2-5 |
| | Rating | 4A, 250VAC | 4A, 250VAC |
| Breaker switch | Type | BAM215131 | BAM215131 |
| | Rating | 250V, 15A | 250V, 15A |
| Switching power supply | Type | ZWS10-12/J | ZWS10-12/J |
| | Input | 100-240VAC | 100-240VAC |
| | Output | DC12V, 0.85A | DC12V, 0.85A |
| Noise filter | Type | ZAC2220-11 | ZAC2220-11 |
| | Rating | AC250V, 20A | AC250V, 20A |

# Specification of sensor

1. Following shows temperature and resistance values in thermistor sensor (502AT-1).

| ℃ | kΩ | ℃ | kΩ | ℃ | kΩ | ℃ | kΩ |
|---|---|---|---|---|---|---|---|
| −50 | 154.5 | −36 | 71.80 | −22 | 35.65 | 0 | 13.29 |
| −49 | 145.9 | −35 | 68.15 | −21 | 33.99 | 5 | 10.80 |
| −48 | 137.8 | −34 | 64.71 | −20 | 32.43 | 10 | 8.84 |
| −47 | 130.2 | −33 | 61.48 | −19 | 30.92 | 15 | 7.20 |
| −46 | 123.1 | −32 | 58.43 | −18 | 29.50 | 20 | 6.01 |
| −45 | 116.5 | −31 | 55.55 | −17 | 28.14 | 25 | 5.00 |
| −44 | 110.2 | −30 | 52.84 | −16 | 26.87 | 30 | 4.17 |
| −43 | 104.4 | −29 | 50.23 | −15 | 25.65 | 35 | 3.50 |
| −42 | 98.87 | −28 | 47.77 | −14 | 24.51 | 40 | 2.96 |
| −41 | 93.70 | −27 | 45.45 | −13 | 23.42 | 45 | 2.51 |
| −40 | 88.85 | −26 | 43.26 | −12 | 22.39 | 50 | 2.13 |
| −39 | 84.18 | −25 | 41.19 | −11 | 21.41 | 55 | 1.82 |
| −38 | 79.80 | −24 | 39.24 | −10 | 20.48 | 60 | 1.56 |
| −37 | 75.67 | −23 | 37.39 | −5 | 16.43 | 65 | 1.35 |

2. Following shows temperature （-170℃～0℃） and resistance values in temp. sensor (Pt1000Ω).

| （℃） | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | 8- | -9 |
|---|---|---|---|---|---|---|---|---|---|---|
| -170 | 330.4 | 326.2 | 322.1 | 318.0 | 313.8 | 309.7 | 305.5 | 301.4 | 297.3 | 293.1 |
| -160 | 371.4 | 367.3 | 363.2 | 359.1 | 355.0 | 350.9 | 346.8 | 342.7 | 338.6 | 334.5 |
| -150 | 412.2 | 408.2 | 404.1 | 400.0 | 395.9 | 391.9 | 387.8 | 383.7 | 379.6 | 375.5 |
| -140 | 452.8 | 448.7 | 444.7 | 440.6 | 436.5 | 432.5 | 428.5 | 424.4 | 420.4 | 416.3 |
| -130 | 493.0 | 489.0 | 485.0 | 481.0 | 477.0 | 472.9 | 468.9 | 464.9 | 460.8 | 456.8 |
| -120 | 533.1 | 529.1 | 525.1 | 521.1 | 517.1 | 513.1 | 509.1 | 505.1 | 501.1 | 497.1 |
| -110 | 572.9 | 569.0 | 565.0 | 561.0 | 557.0 | 553.0 | 549.1 | 545.1 | 541.1 | 537.1 |
| -100 | 612.6 | 608.6 | 604.6 | 600.7 | 596.7 | 592.8 | 588.8 | 584.8 | 580.9 | 576.9 |
| -90 | 652.0 | 648.1 | 644.1 | 640.2 | 636.2 | 632.3 | 628.4 | 624.4 | 620.5 | 616.5 |
| -80 | 691.3 | 687.3 | 683.4 | 679.5 | 675.6 | 671.6 | 667.7 | 663.8 | 659.9 | 655.9 |
| -70 | 730.3 | 726.4 | 722.5 | 718.6 | 714.7 | 710.8 | 706.9 | 703.0 | 699.1 | 695.2 |
| -60 | 769.3 | 765.4 | 761.5 | 757.6 | 753.7 | 749.8 | 745.9 | 742.0 | 738.1 | 734.2 |
| -50 | 808.1 | 804.2 | 800.3 | 796.4 | 792.6 | 788.7 | 784.8 | 780.9 | 777.0 | 773.2 |
| -40 | 846.7 | 842.8 | 839.0 | 835.1 | 831.3 | 827.4 | 823.5 | 819.7 | 815.8 | 811.9 |
| -30 | 885.2 | 881.4 | 877.6 | 873.7 | 869.8 | 866.0 | 862.1 | 858.3 | 854.4 | 850.6 |
| -20 | 923.6 | 919.8 | 915.9 | 912.1 | 908.3 | 904.4 | 900.6 | 896.7 | 892.9 | 889.1 |
| -10 | 961.9 | 958.0 | 954.2 | 950.4 | 946.6 | 942.7 | 938.9 | 935.1 | 931.3 | 927.4 |
| 0 | 1000.0 | 996.2 | 992.4 | 988.6 | 984.8 | 980.9 | 977.1 | 973.3 | 969.5 | 965.7 |

2. Following shows temperature （0℃～100℃） and resistance values in temp. sensor (Pt1000Ω).

| (℃) | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | 8- | -9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1000.0 | 1003.8 | 1007.6 | 1011.4 | 1015.2 | 1019.0 | 1022.8 | 1026.6 | 1030.4 | 1034.2 |
| 10 | 1038.0 | 1041.8 | 1045.6 | 1049.4 | 1053.2 | 1057.0 | 1060.8 | 1064.6 | 1068.4 | 1072.2 |
| 20 | 1076.0 | 1079.7 | 1083.5 | 1087.3 | 1091.1 | 1094.9 | 1098.7 | 1102.4 | 1106.2 | 1110.0 |
| 30 | 1113.8 | 1117.5 | 1121.3 | 1125.1 | 1128.8 | 1132.6 | 1136.4 | 1140.1 | 1143.9 | 1147.7 |
| 40 | 1151.4 | 1155.2 | 1159.0 | 1162.7 | 1166.5 | 1170.2 | 1174.0 | 1177.7 | 1181.5 | 1185.2 |
| 50 | 1189.0 | 1192.7 | 1196.5 | 1200.2 | 1204.0 | 1207.7 | 1211.5 | 1215.2 | 1219.0 | 1222.7 |
| 60 | 1226.4 | 1230.2 | 1233.9 | 1237.6 | 1241.4 | 1245.1 | 1248.8 | 1252.6 | 1256.3 | 1260.0 |
| 70 | 1263.8 | 1267.5 | 1271.2 | 1274.9 | 1278.7 | 1282.4 | 1286.1 | 1289.8 | 1293.5 | 1297.2 |
| 80 | 1301.0 | 1304.7 | 1308.4 | 1312.1 | 1315.8 | 1319.5 | 1323.2 | 1326.9 | 1330.6 | 1334.3 |
| 90 | 1338.0 | 1341.7 | 1345.4 | 1349.1 | 1352.8 | 1356.5 | 1360.2 | 1363.9 | 1367.6 | 1371.3 |
| 100 | 1375.0 | 1378.7 | 1382.4 | 1386.1 | 1389.8 | 1393.4 | 1397.1 | 1400.8 | 1404.5 | 1408.2 |

# Control specifications

**1. Keys on the control panel**

BUZZER : In alarm condition, buzzer stops sounding with this key pressed. Remote alarm output and alarm message would not be off. During the power failure (battery back-up), press the key to show the chamber temperature for 5 seconds.

ALARM TEST : With this key pressed to activate alarm test mode to be forcibly step into alarm condition (ALARM lamp blinks, intermittent buzzer beeps, digital LED goes off and remote alarm activates). After approx. 90seconds then, unit retrieves normal condition by Auto Return. With the battery switch turns off, "E09" blinks on the display.

SET : Press this key once to blink 2 $^{nd}$ digit on the display and press the key again to store the value to be changed.

▶▶ (Digit shift key) During setting mode, press the key to shift the blinking digit. In chamber temperature display, press this key over 5 seconds to shift to Key Lock screen with 'L_0' displayed.

▲▲ (Numerical value shift key) During setting mode, press the key to change the blinking digit. In chamber temperature display, press the key over 5 seconds to enter the function mode. ("F00" is displayed)

**2. Temperature control**

Setting range : -50℃~-90℃

Display range : -180℃~+50℃

Setting procedure : Press SET key and set the required value with ▲▲ key and ▶▶ key. Press SET key to store the set value.

Unacceptable setting range : If you try to set the value which deviates from setting range, the buzzer beeps for 1 second to inform the value unacceptable.

**3. Key Lock mode**

Setting range : 0, 1

Setting procedure: In chamber temperature display, keep pressing ▶▶ key over 5 seconds to enter into Key Lock mode. ("L_0" or "L_1" is displayed. initial: L_0) with "0" or "1" blinks.
Change the value with ▲▲ key and press SET key to store the value in the non-volatile memory.
0: Unlocked
1: Locked

**4. Function mode**

Setting range : 00~32

Display range : 00~39
00, 16 and 33~39 are unavailable.

Setting procedure : In chamber temperature display, keep pressing ▲▲ key over 5 seconds to enter function mode (F00 is displayed). Change the blinking 1$^{st}$ digit to desired function code with ▲▲ key and ▶▶ key. Press SET key to be function code available.
If you input 00 and 16 then press SET key, automatically revert to chamber temperature display.

Unacceptable setting range : If you try to input the value among F33~F39, the buzzer beeps to inform the value unacceptable.

## 5. Error codes

E01: Temp. sensor is open circuited
E02: Temp. sensor is short circuited
E03: Cascade sensor is open circuited
E04: Cascade sensor is short circuited
E05: Filter sensor is open circuited
E06: Filter sensor is short circuited
E07: AT sensor is open circuited
E08: AT sensor is short circuited
E09: Battery switch is off position
E10: Compressor temperature is abnormal

(1) Temp. sensor

Open circuit (E01): When temperature in PT sensor is equal or higher than 50℃, E01 and 50℃ are displayed alternately and the buzzer beeps intermittently and remote alarm contact activates.
Compressor keeps forcibly running.
Press BUZZER key to stop the buzzer beeping.

Short circuit (E02): When temperature in PT sensor is equal or lower than -170℃, E02 and -170 ℃ ~ -180 ℃ are displayed alternately and the buzzer beeps intermittently and remote alarm contact activates.
Compressor keeps forcibly running.
Press BUZZER key to stop the buzzer beeping.

(2) Cascade sensor

Open circuit (E03): When temperature in cascade sensor is equal or higher than 60℃, E03 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
High side compressor is forcibly turned on and low side compressor is turned off.
Press BUZZER key to stop the buzzer beeping.

Short circuit (E04): When temperature in cascade sensor is equal or lower than -65℃, E04 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
High side compressor is forcibly turned on and low side compressor is not controlled in any cascade temperature.
Press BUZZER key to stop the buzzer beeping.

(3) Filter sensor

Open circuit (E05): When the temperature in filter sensor is equal or higher than 130℃, E05 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
High side compressor is forcibly turned off.
Press BUZZER key to stop the buzzer beeping.

Short circuit (E06): When the temperature in filter sensor is equal or lower than -60℃, E06 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
Press BUZZER key to stop the buzzer beeping.

(4) AT sensor

Open circuit (E07): When the temperature in AT sensor is equal or higher than 60℃, E07 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
Press BUZZER key to stop the buzzer beeping.

Short circuit(E08): When the temperature in AT sensor is equal or lower than -60℃, E08 and chamber temperature are displayed alternately, the buzzer beeps intermittently and remote alarm contact activates.
Press BUZZER key to stop the buzzer beeping.

(5) Battery SW is off position (E09): If you press ALARM TEST key when battery switch is off position or battery is unconnected, E09 is displayed.

(6)Compressor abnormal temperature (E10): When the temperature in filter sensor is equal or higher than 60℃, E10 and chamber temperature are displayed alternately and high side compressor is forcibly turned off to inform compressor temperature is abnormal or fan motor locked.
Press BUZZER key to stop the buzzer beeping.
When the temperature in filter sensor – AT is equal or lower than 10℃, compressor is turned on again.

(7) Error code priority

No.1: Cascade sensor (E03, E04) … Compressor is forcibly turned off
No.2: Filter sensor (E05, E06) … Compressor protection is uncontrollable
No.3: Abnormal compressor temp.(E10) … Compressor temporary turns off
No.4: Temp. sensor (E01, E02) … Compressor keeps forcibly running
No.5: AT sensor (E07, E08) … Warming-up operation in any ambient temp.

## 6. Alarms

High temp. alarm : When chamber temperature is equal or higher than set temperature + high temp. alarm set temperature +1.0, ALARM lamp and LED display blink, intermittent buzzer beeps with approx. 10 minutes of delay and remote alarm activates.
When chamber temperature is equal or lower than set temperature, ALARM lamp and LED display go off, buzzer stops beeping and remote alarm turns off.
If you press BUZZER key, the buzzer stops beeping instead remote alarm does not turn off.

Low temp. alarm : When chamber temperature is equal or lower than set temperature - low temp. alarm set temperature -1.0, ALARM lamp and LED display blinks, intermittent buzzer beeps with approx. 15 minutes of delay and remote alarm activates.
When chamber temperature is equal or higher than set temperature – low temp. alarm set temperature, ALARM lamp and LED display go off, buzzer stops beeping and remote alarm output turns off.
If you press BUZZER key, the buzzer stops beeping instead remote alarm does not turn off.

Power failure alarm : With the battery switch is on position and power switch is turned off or the power is interrupted for 3 seconds, ALARM lamp blinks and intermittent buzzer beeps and remote alarm activates.
When the power retrieves within 3 seconds after the power failed, micro computer is initialized and remote alarm turns off.
Press BUZZER key to stop buzzer beeping instead remote alarm does not turn off.
Remote alarm activates until chamber temperature is stabilized.
You can check chamber temperature for 5 seconds if you press BUZZER key during power failure.

Filter alarm : When the temperature in filter sensor is equal or higher than +45.5℃, FILTER lamp is lit and buzzer beeps intermittently.
Buzzer tone is selectable ON/OFF in F31. (000:OFF 001:ON)
Remote alarm does not turn over.
When the temperature in filter sensor is lower than +40.5℃, FILTER lamp goes off and buzzer stops beeping.

## 7. Other functions

Auto Return : If there is not any key operation for 90 seconds in each setting mode, Key Lock mode and Function mode, automatically reverts to chamber temperature mode.
Note) Auto Return is not worked in F09 and F10.

Alarm resume time : This is the function to prevent someone pressing BUZZER key to stop buzzer beeping when the unit is into alarming condition.
Press BUZZER key to stop buzzer beeping. Buzzer beeps again after a certain alarm resume time elapses.
Alarm resume time is settable in F25. (See Function mode for details)

Sensor temperature : F12: Temperature of temp. sensor is displayed
(Ex. -80.2℃ → displayed as '80.2')
F13: Temperature of cascade sensor is displayed.
(Ex. +67℃ → displayed as '067℃')
F14: Temperature of filter sensor is displayed.
(Ex. 67℃ → displayed as '067')
F15: Temperature of AT sensor is displayed.
(Ex. 30℃ → displayed as '030')

Battery accumulation time : F03: Battery accumulation time is displayed.
(Ex. 2years and 6months accumulated → displayed as '02.5')
The display shows '02.8' to inform the battery exhaustion.
Replace with new battery.
<Reset of accumulation time>
Step into F06. Input '**409**' and press SET key to turn the display to '00.0' with BATTERY lamp (DP55) goes off.

Condensing fan motor accumulation time : F32: Condensing fan motor accumulation time is displayed.
(Ex. 5years and 6months consumed → displayed as '05.5')
<Reset of accumulation time>
Step into F06. Input '**419**' and press SET key to turn the display to '00.0' with DP55 lamp goes off.

Capillary heater operation : F18: Input '000' to stop compressor operation and to conduct electricity in capillary heater. Input '000' again to stop capillary heater operation when capillary heater is conducted electricity.
Input '001' to have capillary heater inoperative, while the compressor stops operation in every 18 hours.

ROM version : F30: ROM version is displayed (Ex. Ver. 1.00 → displayed as "1.00")

## 8. Function mode

| | |
|---|---|
| F01 | Setting of High temp. alarm set temperature |
| F02 | Setting of Low temp. alarm set temperature |
| F03 | Display of battery accumulation time |
| F05 | Setting of compressor delay time |
| F06 | Service code input (code: 384) |
| F07 * | Temp. sensor Zero Adjustment |
| F08 * | Cascade sensor Zero Adjustment |
| F09 | Factory test mode …… Unavailable |
| F10 | Factory test mode …… Unavailable |
| F11 | Factory test mode …… Unavailable |
| F12 * | Display of temperature in temp. sensor |
| F13 * | Display of temperature in cascade sensor |
| F14 * | Display of temperature in compressor sensor |
| F15 * | Display of temperature in AT sensor |
| F17 * | Model code setting (Initialization of non-volatile ROM and memory) |
| F18 * | Capillary heater is forcibly turned on/off |
| F19 | Factory test mode …… Unavailable |
| F20 | Factory test mode ... ... Unavailable |
| F21 | Communication ID set ... ... Unavailable |
| F22 | Communication mode set ... ... Unavailable |
| F23 * | Display of power supply voltage |
| F24 | Remote alarm terminal output |
| F25 | Alarm resume time set |
| F26 * | Display of actual operation rate |
| F27 * | Display of diagnosis value for running rate ... ... Unavailable |
| F28 * | Factory test mode …… Unavailable |
| F29 * | Factory test mode …… Unavailable |
| F30 * | ROM version is displayed |
| F31 * | Selectable buzzer ON/OFF setting in filter alarm |
| F32 * | Display of condensing fan motor accumulating time |

Setting procedure:
In chamber temperature display, keep pressing ⏫ key over 5seconds to display “F00”.
Input the desired function code with ⏫ key and ⏩ key.
Press SET key to be function mode available.
* … You should input service code in F06 beforehand.
To cancel service code, input “000” in F06 or turn the power off.

F01: <Purpose> To set high temp. alarm set temperature
<Operation> Input F01 and press SET key to display “010” (initial value).
Set the value in the range “005”~“020” with ⏫ key and ⏩ key.
Press SET key to store the value and revert to chamber temperature display.

F02: <Purpose> To set low temp. alarm set temperature
<Operation> Input F02 and press SET key to display “-10” (initial value).
Set the value in the range “-05”~“-20” with ⏫ key and ⏩ key.
Press SET key to store the value and revert to chamber temperature display.

F03: <Purpose> Battery accumulation time is displayed
<Operation> Input F03 and press SET key to display alternately F03 with “00.0” (in case battery used for a month or less). Press SET key to revert to chamber temperature display.
<Reset> Input ‘**409**’ and press SET key to initialize battery accumulation time. (’00.0’ is displayed)

F05: <Purpose> To have compressor operation being delayed when the power is supplied or the power retrieves from the power failure.
(Unit: Minute)

<Operation> Input “F05” and press SET key to display “003” (initial).
Change the value in the range “003”~”015” with ▲▲ key and ▶▶ key.
Press SET key to store the value and revert to chamber temperature display.

F06: <Purpose> Dividing F-code for customer used from service

<Operation> Input F06 and press SET key to display “000” (initial value).
Set to “384” with ▲▲ key and ▶▶ key. Press SET key to store the value and revert to chamber temperature display.

<Cancel> Input F06 and press SET key to display “384”.
Change to “000” with ▲▲ key and ▶▶ key. Press SET key to store the value and revert to chamber temperature display.
Service code ‘384’ is not effective after the reset of battery or fan motor accumulation time.
Power the unit on and off to initialize (‘000’) service code which is not memorized in non-volatile memory.
Note) ‘384’ is storied in non-volatile memory during battery back-up. (battery SW is ON)

<Reset of battery accumulation time>
Input service code, ‘384’ then ‘409’ to reset battery accumulation time. Unit automatically reverts to chamber temperature display.

<Reset of fan motor accumulation time>
Input service code, ‘384’ then ‘419’ to reset fan motor accmulation time. Unit automatically reverts to chamber temperature display.

F07: <Purpose> To match temperature of temp. sensor with temperature of center at the chamber.

<Operation> Input service code in F06 prior to use this mode.
Input F07 and press SET key to display “00.0” (initial value).
Change to the desired value in the range “-4.9”~”04.9” with ▲▲ key and ▶▶ key.
Press SET key to store the value and revert to chamber temperature display.
(Ex.) When you change from ’00.0’ to ’02.0’, chamber temperature goes about 2℃ lower

F08: <Purpose> To calibrate temperature of cascade sensor

<Operation> Input service code in F06 prior to use this mode.
Input F08 and press SET key to display “00.0” (initial value).
Change to the desire value in the range “-9.9”~”09.9” with ▲▲ key and ▶▶ key.
Press SET key to store the value and revert to chamber temperature display.

F12: <Purpose> To display the temperature of temp. sensor

<Operation> Input service code in F06 prior to use this mode.
Input F12 and press SET key to display alternately F12 and “XX.X” (present internal temperature). Press SET key to revert to chamber temperature display. 3 digits indication. Minus “-“ is not indicated.
Ex) “-79.5℃” → indicated as “79.5”

F13: <Purpose> To display the temperature of cascade sensor
<Operation> Input service code in F06 prior to use this mode.
Input F13 and press SET key to display alternately F13 and “XX.X” (present temperature of cascade sensor). Press SET key to revert to chamber temperature display.

F14: <Purpose> To display the temperature of filter sensor
<Operation> Input service code in F06 prior to use this mode.
Input F14 and press SET key to display alternately F14 and “XX.X” (present temperature of filter sensor). Press SET key to revert to chamber temperature display.

F15: <Purpose> To display the temperature of AT sensor
<Operation> Input service code in F06 prior to use this mode.
Input F15 and press SET key to display alternately F15 and “XX.X” (present temperature of AT sensor). Press SET key to revert to chamber temperature display.

F17: <Purpose> Non-volatile memory initialization, model code change
<Operation> Service code should be input in F06 prior to use this mode.
Input F17 and press SET key to display “00X”. Change the value with ⏫ key and ⏩ key. Press SET key to store and revert to chamber temperature display.
Model code is identified by its power source.
**Model code ‘006’: for 220-240V**

<Initial values in Non-volatile memory>

| | |
|---|---|
| PT sensor Zero Adjustment value | : 0℃ |
| Cascade sensor Zero Adjustment value | : 0℃ |
| Capillary heater turning on time | : 8 min. |
| Auto Recovery time | : 30 min. |
| Chamber temperature | : -80℃ |
| High temp. alarm temperature | : +10℃ |
| Low temp. alarm temperature | : - 10℃ |
| Compressor delay time | : 3 min. |
| Communication ID | : 000 |
| Communication mode | : 000 |
| Key Lock | : OFF |
| Remote alarm and buzzer operation | : OFF |
| Filter alarm buzzer | : OFF |
| Data to check non-volatile memory | : |

F18: <Purpose> To turn capillary heater on/off
<Operation> Service code should be input in F06 prior to use this mode.
Input F18 and Press SET key to display “000” (initial).
Change to desire value “000” or “001” with ⏫ key and ⏩ key.
Press SET key to store the value and revert to chamber temperature display.
000: Capillary heater is forcibly turned on/off
001: Capillary heater is inoperative

F23: <Purpose> To display the power supply voltage (Unit: %)
<Operation> Service code should be input in F06 prior to use this mode.
Input F23 and press SET key to display F23 and ‘xxx’ (present power supply voltage) alternately. Press SET key to revert to chamber temperature display.

F24: <Purpose> To set remote alarm and buzzer operation
<Operation> Input F24 and Press SET key to display “000” (initial).
Change to the desired value with ▲▲ key and ▶▶ key.
Press SET key to store the value and revert to chamber temperature display.
000: Remote alarm operation is not synchronous with buzzer
001: Remote alarm operation is synchronous with buzzer

F25: <Purpose> Alarm auto recovery time setting
<Operation> Input F25 and press SET key to display “030” (initial).
Change to the desired value with ▲▲ key and ▶▶ key.
Press SET key to store the value and revert to chamber temperature display.
000: Auto recovery OFF
010: Recovers after 10min. elapse
020: Recovers after 20min. elapse
030: Recovers after 30min. elapse (initial)
040: Recovers after 40min. elapse
050: Recovers after 50min. elapse
060: Recovers after 60min. elapse

F26: <Purpose> Running rate is displayed (unit: %)
<Operation> Service code should be input in F06 prior to use this mode.
Input F26 and press SET key to display alternately F26 with “XXX” (present running rate).
Press SET key to revert to chamber temperature display.

F30: <Purpose> ROM version is displayed
<Operation> Service code should be input in F06 prior to use this mode.
Input F30 and press SET key to display alternately F30 with “1.00” (Version 1.00).
Press SET key to revert to chamber temperature display.

F31: <Purpose> Selectable buzzer ON/OFF setting during filter alarm
<Operation> Input F31 and press SET key to display “000” (initial).
Change to the desired value with ▲▲ key and ▶▶ key.
Press SET key to revert to chamber temperature display.
000: Buzzer OFF
001: Buzzer ON

F32: <Purpose> To display condensing fan motor accumulation time
<Operation> Input F32 and press SET key to display alternately F32 with ’00.0’ (in case accumulation period is within 36days).
Press SET key to revert to chamber temperature display.
<Reset> Input ‘419’ in F06 and press SET key to initialize fan motor accumulation time. (’00.0’ is displayed)

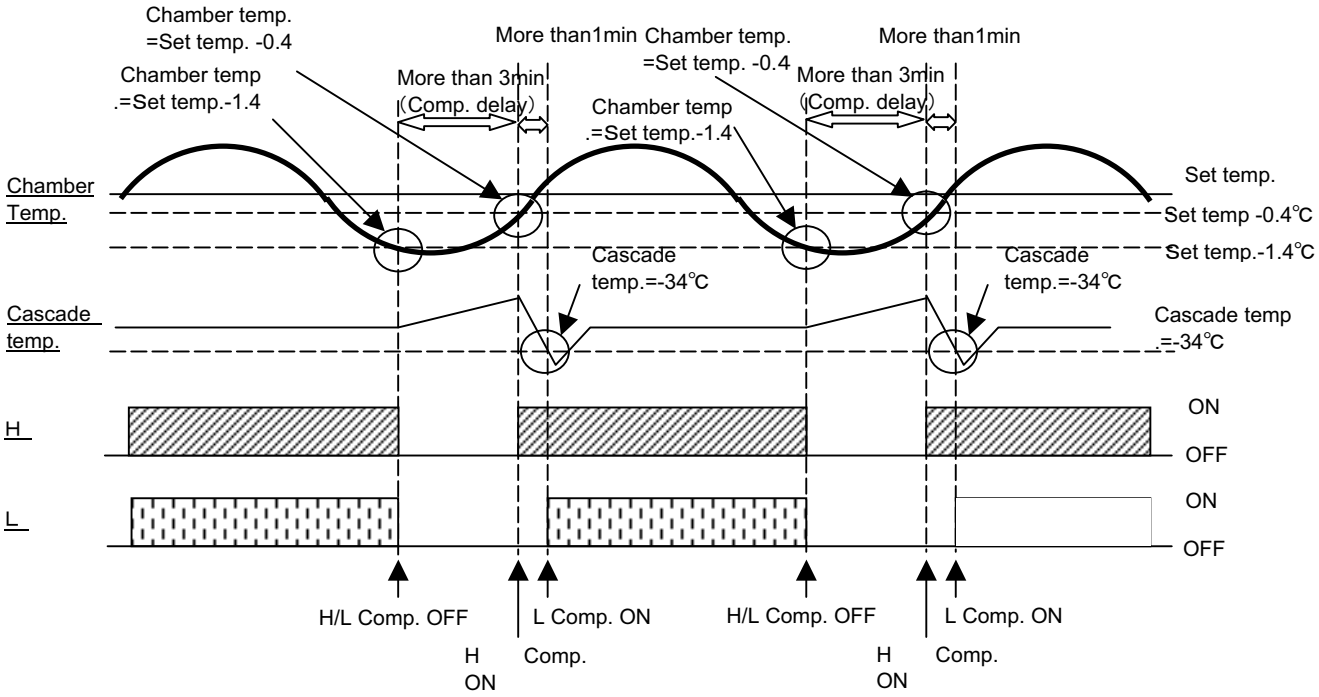
## 9. Control of compressor

Differential temperatures

When chamber temp. is set temp. -0.4℃ : H side compressor turns on.
When chamber temp. is set temp. -1.6℃ : Both H/L side compressors turn off.
When H side compressor turns on and cascade temp. is -34℃ : L side compressor turns on.
Interval of H/L compressor ON : 1min.

*Note) L side compressor turns on only when cascade temperature is reached to -34℃ after 1 minute elapse since H side compressor was turned on.

<Compressor control during cycle operation>




H side compressor protection:
H side compressor is turned off to prevent the compressor being warmed up that is caused by the fan motor locked.

Filter sensor temperature:
The High side compressor is turned off when the filter sensor temperature is equal or higher than 60℃. The High side compressor is turned on again when the filter sensor temperature is equal or lower than ambient temperature +10℃.

## 10. Delay time

Compressor delay time (Initial: 3 minutes)
When the compressor seizes during cycle operation, both L/H side compressors restart with the delay time. You can choose delay time in F05.

Power failure alarm delay time (About 3 seconds, fixed)
When the power is failed, the power failure alarm activates with about 3 seconds of delay.
The delay time is fixed.

## 11. Prevention for oil logged in the capillary

Purpose:

Capillary heater is conducted electricity by regularly turning both L/H side compressor off to prevent oil logged in the capillary.

Operation:

Both L/H side compressor are turned off, while the capillary heater relay is turned on.

Frequency:

8 minutes in every 18 hours (Minutes are changeable in F19)

Timing of operation:

(1) About 9 seconds after both L/H side compressors are turned off during cycle operation.
(2) Both L/H side compressors are forcibly turned off if they keep running for 60 minutes or more after they were ordered to turn off.

Operation of capillary heater:

Capillary heater is forcibly ON/OFF controlled in F18.

## 12. Sensor offset

Sensor offset value:

(1) Temperature sensor: +1.3℃ (Changeable in F07)
(2) Cascade sensor: +/-0.0℃ (Changeable in F08)
(3) Filter sensor: +/-0.0℃
(4) AT sensor: +/-0.0℃

## 13. Remote alarm terminal

Operation:

Once the alarm is triggered, the remote alarm contact (RLY2) switches the position.

| | CN3 | |
|---|---|---|
| | 1 – 2 (N.O.) | 1 – 3 (N.C.) |
| Normal | Open | Close |
| In alarm | Close | Open |

## 14. Power reset

Setting values after the power is reset:

Alarms: OFF
Compressors: OFF
Remote alarm: OFF
Alarm resume time: 30 minutes
Door alarm delay time: 2 minutes
Timers: Reset
Counting for L side compressor OFF period: Reset
Setting data: Referred to non-volatile memory

Momentary power failure:

Status of the unit should be diagnosed by comparing the chamber temperature with the set temperature. When the chamber temperature is equal or lower than the set temperature +10℃, it diagnoses as ‘Momentary power failure’.

Setting values after power retrieves from power failure:

Alarms: OFF
Compressors: OFF
Remote alarm: ON
Timers: Reset
2H timer, 8H timer: 0 (Reset)
Counting of period Low side compressor turns off: Reset

## 15. Lamp, display and buzzer specifications

Lamp operation:

<Control PCB>

DP1: Orange lamp
Goes off: High/low temp. alarm (15min. delay), sensor error, power failure
Lit : Not in alarm condition

DP2: Green lamp
Goes off: L side compressor turns off. (normal condition)
Lit : L side compressor turns on.

DP3: Red lamp
Goes off: Capillary heater turns off. (normal condition)
Lit : Capillary heater turns on.

DP6: Green lamp
Goes off: H side compressor turns off. (normal condition)
Lit : H side compressor turns on.

<Display PCB>

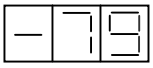
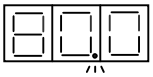
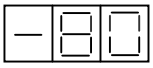
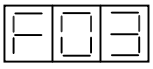
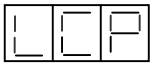
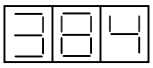
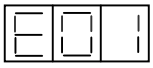
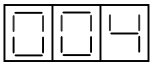
DP51: Red lamp
Blinks : High/low temp. alarm (without delay), or sensor failure, or power failure

DP53: Orange lamp
Lit : In filter alarm

DP54: Red lamp
Lit : Door ajar

DP55: Orange lamp
Lit : Battery accumulation time is reached to about 3 years
Blinks : Fan motor accumulation time is reached to about 6 years

Examples of display:

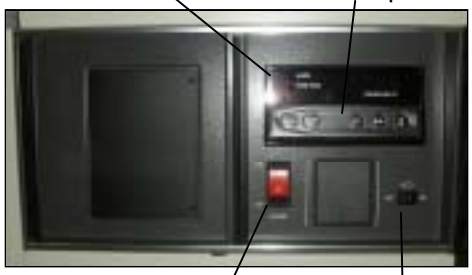
| | | | | | |
|---|---|---|---|---|---|
| Chamber temp. | -79.5℃ |  | Decimal point of chamber temp. | -80.0 |  |
| Set temp. | -80.0℃ |  | Sensor offset | -5.0 | |
| Function | F03 |  | Operation monitoring | LCP |  |
| Service code | 384 |  | Error | E01 |  |
| Set value | 004 |  | Accumulation time | 8H timer 135 | |
| Key Lock | L_0 | | | | |

Buzzer tone:

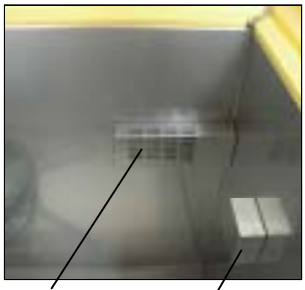
| | |
|---|---|
| Alarms | Intermittent tone |
| Key operation | Click tone |
| Set value memory | Click tone |
| Out of settable range | 1 second continuous tone |
| Filter blockage | Intermittent tone |

# Parts layout

<Front view>



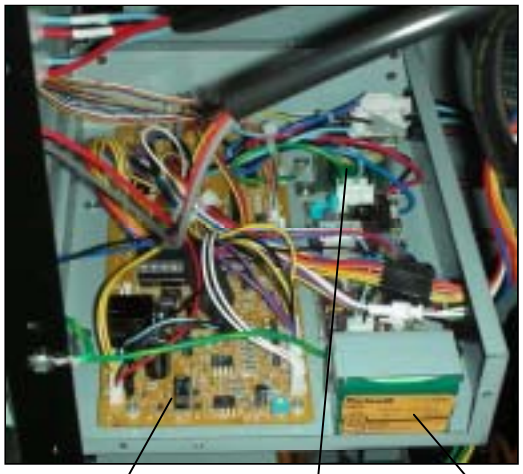

<In the chamber>



<Back side of control panel>

<Left side area>

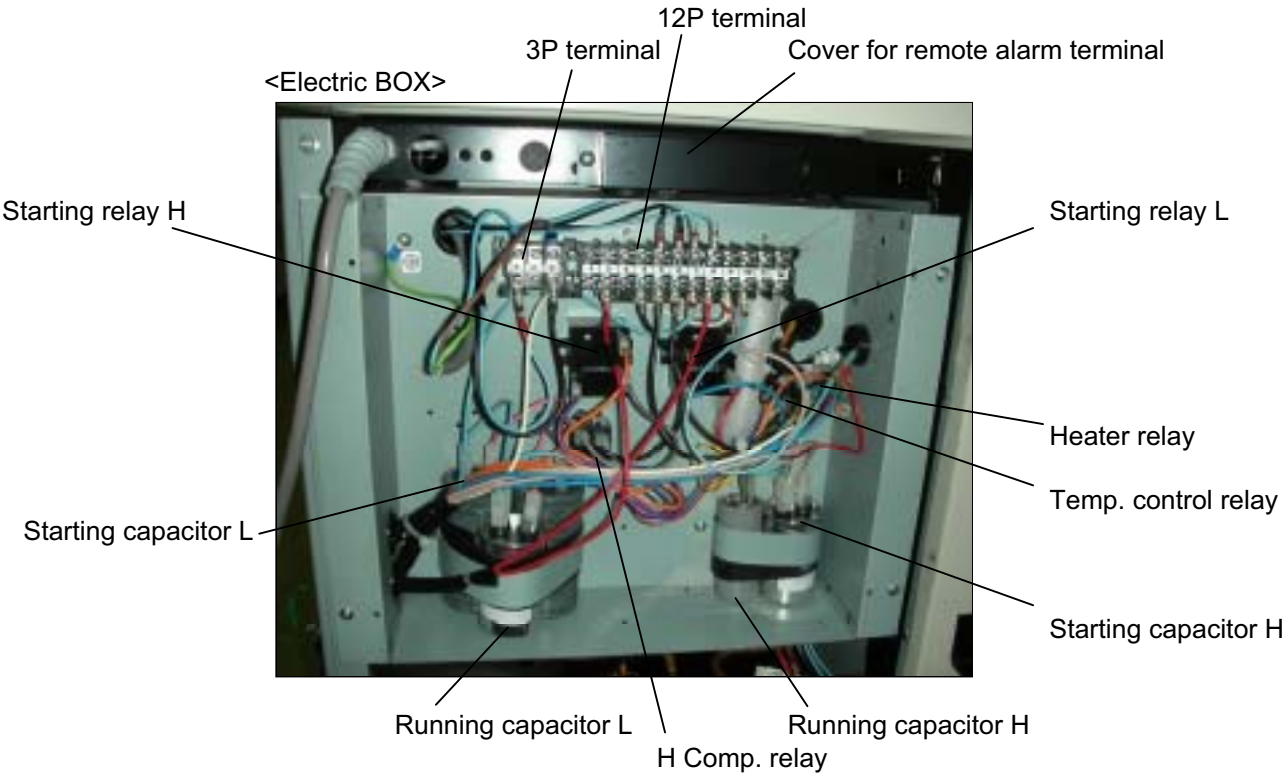
<Temp. control PCB>



<Left side - Top cover removed>

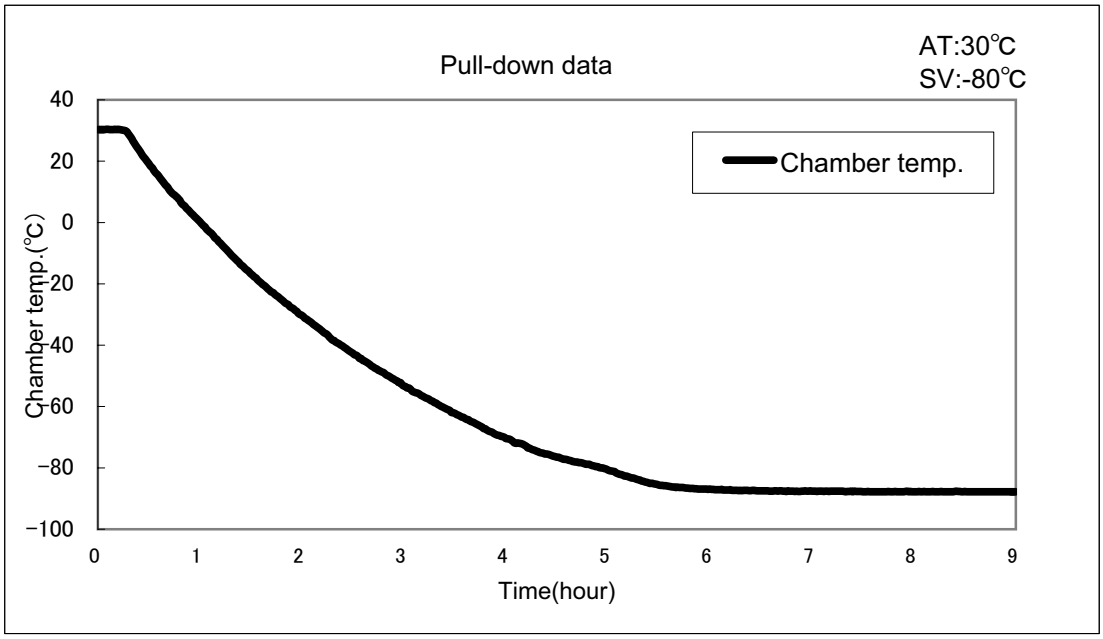
<Back side / Remote alarm terminal>

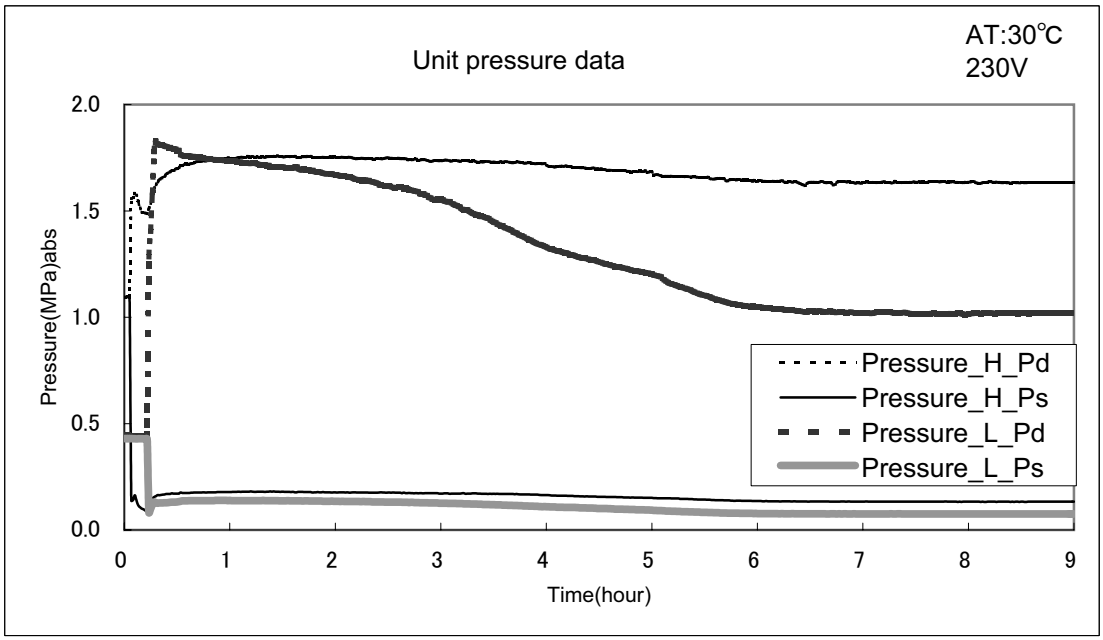
<Electric BOX>

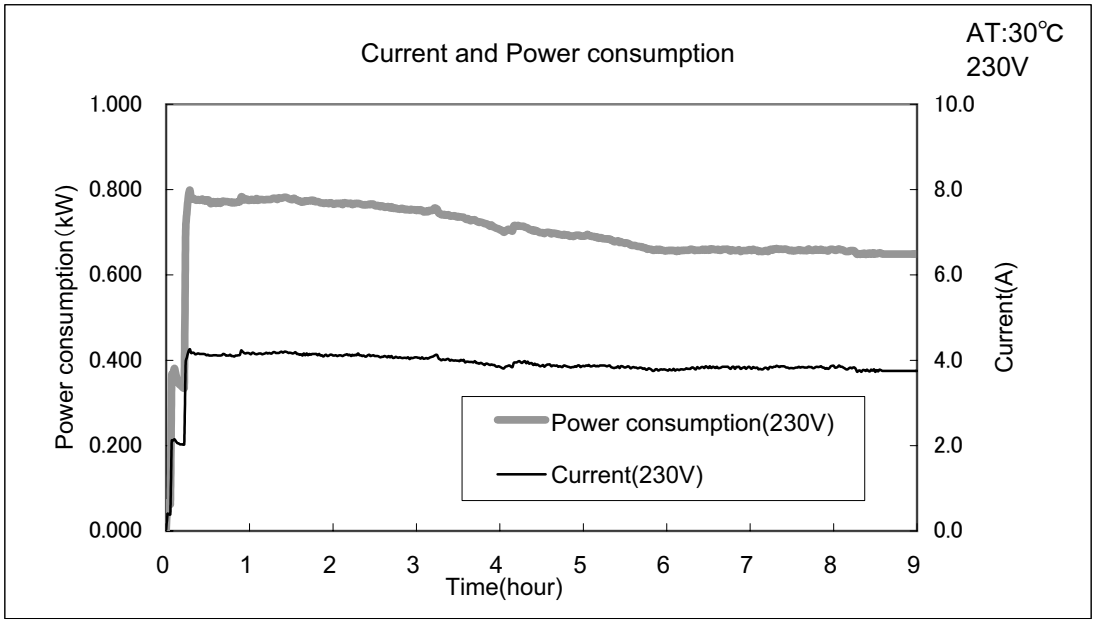


# Test data

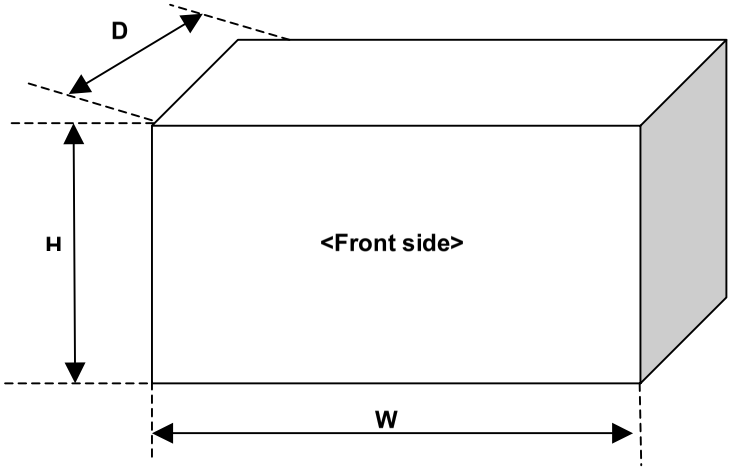
*All the data are the reference only.

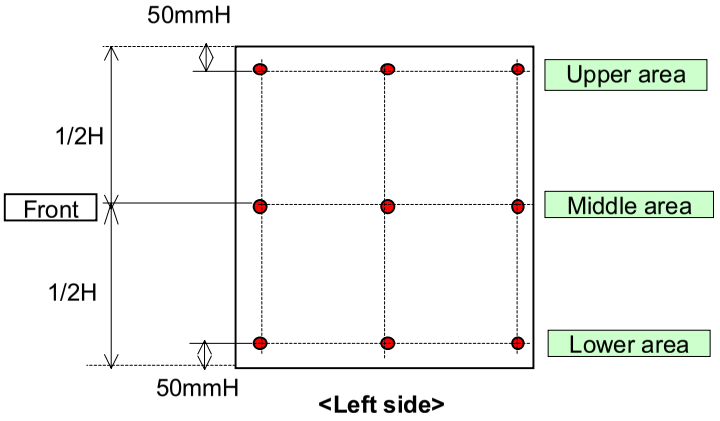


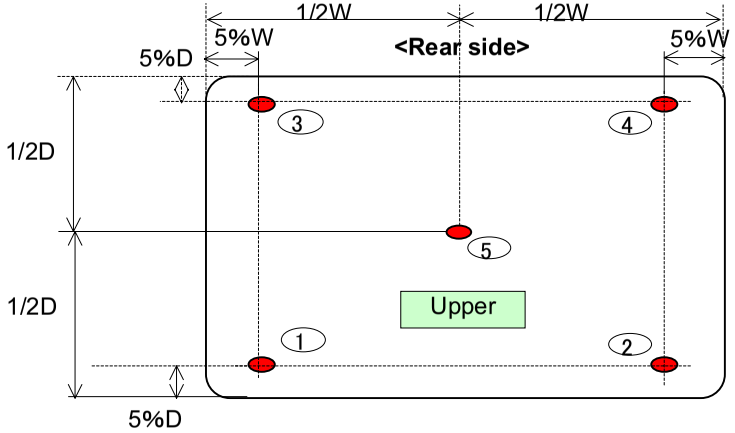



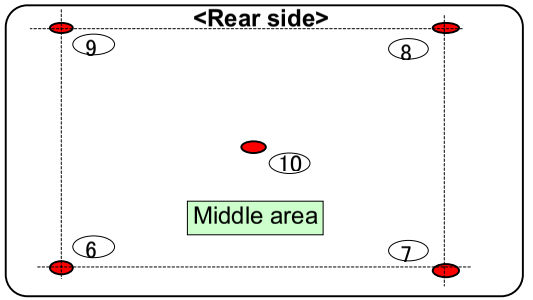

Current and Power consumption
AT:30℃
230V
Power consumption (kW)
Current(A)
Time(hour)
Power consumption(230V)
Current(230V)
1.000
0.800
0.600
0.400
0.200
0.000
10.0
8.0
6.0
4.0
2.0
0.0
0
1
2
3
4
5
6
7
8
9

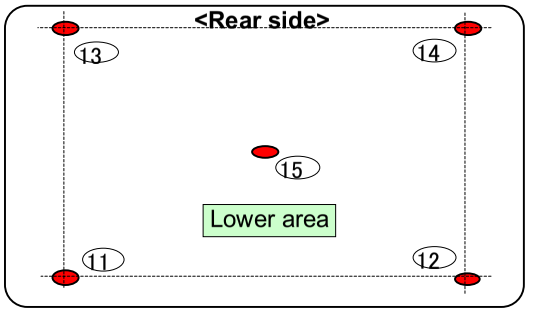
**Measure points:**



| | SV:-80℃ AT:20℃ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100V50Hz | | | | 100V60Hz | | | |
| | Max | Min | Center | Variation | Max | Min | Center | Variation |
| ① | -72.5 | -81.3 | -76.9 | ±4.4 | -71.7 | -82.1 | -76.9 | ±5.2 |
| ② | -72.9 | -81.3 | -77.1 | ±4.2 | -72.2 | -82.4 | -77.3 | ±5.1 |
| ③ | -72.4 | -81.1 | -76.7 | ±4.4 | -71.9 | -81.6 | -76.8 | ±4.9 |
| ④ | -72.2 | -81.1 | -76.6 | ±4.5 | -71.9 | -81.6 | -76.8 | ±4.8 |
| ⑤ | -70.9 | -81.2 | -76.0 | ±5.2 | -70.3 | -80.3 | -75.3 | ±5.0 |
| ⑥ | -77.1 | -82.5 | -79.8 | ±2.7 | -77.6 | -83.8 | -80.7 | ±3.1 |
| ⑦ | -77.9 | -82.6 | -80.2 | ±2.4 | -78.3 | -83.9 | -81.1 | ±2.8 |
| ⑧ | -77.6 | -82.6 | -80.1 | ±2.5 | -78.4 | -83.7 | -81.0 | ±2.7 |
| ⑨ | -76.8 | -82.5 | -79.7 | ±2.9 | -77.6 | -84.0 | -80.8 | ±3.2 |
| ⑩ | -78.2 | -83.2 | -80.7 | ±2.5 | -78.6 | -84.8 | -81.7 | ±3.1 |
| ⑪ | -78.0 | -83.9 | -80.9 | ±3.0 | -78.4 | -85.0 | -81.7 | ±3.3 |
| ⑫ | -77.2 | -82.3 | -79.7 | ±2.5 | -78.0 | -84.0 | -81.0 | ±3.0 |
| ⑬ | -77.6 | -83.4 | -80.5 | ±2.9 | -78.1 | -84.7 | -81.4 | ±3.3 |
| ⑭ | -77.8 | -83.7 | -80.8 | ±2.9 | -78.0 | -84.6 | -81.3 | ±3.3 |
| ⑮ | -78.2 | -82.6 | -80.4 | ±2.2 | -78.9 | -84.5 | -81.7 | ±2.8 |
| Ave. | | | -79.1 | | | | -79.7 | |

Amount of power consumption

| SV | -80℃ | |
|---|---|---|
| AT | 20℃ | |
| Power source | 100V50Hz | 100V60Hz |
| kWh/day | 10.7 | 10.3 |

| | SV:-80℃ AT:30℃ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100V50Hz | | | | 100V60Hz | | | |
| | Max | Min | Center | Variation | Max | Min | Center | Variation |
| ① | -72.3 | -80.8 | -76.6 | ±4.3 | -71.1 | -81.7 | -76.4 | ±5.3 |
| ② | -72.4 | -81.0 | -76.7 | ±4.3 | -71.7 | -81.9 | -76.8 | ±5.1 |
| ③ | -71.9 | -80.8 | -76.4 | ±4.4 | -71.1 | -81.2 | -76.2 | ±5.0 |
| ④ | -71.9 | -80.9 | -76.4 | ±4.5 | -71.4 | -81.2 | -76.3 | ±4.9 |
| ⑤ | -70.7 | -80.4 | -75.5 | ±4.9 | -69.7 | -80.0 | -74.8 | ±5.1 |
| ⑥ | -77.2 | -82.4 | -79.8 | ±2.6 | -77.3 | -83.4 | -80.4 | ±3.0 |
| ⑦ | -77.8 | -82.6 | -80.2 | ±2.4 | -78.2 | -83.6 | -80.9 | ±2.7 |
| ⑧ | -77.8 | -82.2 | -80.0 | ±2.2 | -78.0 | -83.3 | -80.6 | ±2.6 |
| ⑨ | -76.6 | -82.1 | -79.4 | ±2.8 | -77.1 | -83.4 | -80.2 | ±3.1 |
| ⑩ | -78.0 | -83.5 | -80.7 | ±2.8 | -78.3 | -84.2 | -81.2 | ±3.0 |
| ⑪ | -77.6 | -83.5 | -80.6 | ±2.9 | -78.0 | -84.6 | -81.3 | ±3.3 |
| ⑫ | -77.2 | -82.4 | -79.8 | ±2.6 | -77.6 | -83.6 | -80.6 | ±3.0 |
| ⑬ | -77.5 | -83.0 | -80.3 | ±2.7 | -77.7 | -84.2 | -81.0 | ±3.3 |
| ⑭ | -77.6 | -83.4 | -80.5 | ±2.9 | -77.5 | -84.4 | -80.9 | ±3.4 |
| ⑮ | -78.2 | -82.4 | -80.3 | ±2.1 | -78.6 | -84.0 | -81.3 | ±2.7 |
| Ave. | | | -78.9 | | | | -79.3 | |

Amount of power consumption

| SV | -80℃ | |
|---|---|---|
| AT | 30℃ | |
| Power source | 100V50Hz | 100V60Hz |
| kWh/day | 12.1 | 11.5 |

| | SV:-70℃ AT:20℃ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100V50Hz | | | | 100V60Hz | | | |
| | Max | Min | Center | Variation | Max | Min | Center | Variation |
| ① | -63.7 | -71.5 | -67.6 | ±3.9 | -64.2 | -71.2 | -67.7 | ±3.5 |
| ② | -64.1 | -71.8 | -68.0 | ±3.9 | -64.3 | -72.0 | -68.1 | ±3.8 |
| ③ | -63.7 | -71.4 | -67.5 | ±3.8 | -63.9 | -71.4 | -67.7 | ±3.7 |
| ④ | -63.8 | -71.4 | -67.6 | ±3.8 | -64.0 | -71.1 | -67.6 | ±3.6 |
| ⑤ | -62.3 | -70.7 | -66.5 | ±4.2 | -62.5 | -70.8 | -66.6 | ±4.2 |
| ⑥ | -67.2 | -72.7 | -70.0 | ±2.8 | -67.2 | -72.4 | -69.8 | ±2.6 |
| ⑦ | -67.7 | -72.9 | -70.3 | ±2.6 | -67.8 | -73.1 | -70.5 | ±2.6 |
| ⑧ | -67.7 | -72.3 | -70.0 | ±2.3 | -67.7 | -72.0 | -69.9 | ±2.1 |
| ⑨ | -67.0 | -72.4 | -69.7 | ±2.7 | -67.1 | -72.2 | -69.6 | ±2.5 |
| ⑩ | -68.0 | -72.9 | -70.4 | ±2.4 | -68.3 | -72.7 | -70.5 | ±2.2 |
| ⑪ | -68.7 | -75.2 | -72.0 | ±3.2 | -68.8 | -75.3 | -72.1 | ±3.2 |
| ⑫ | -67.6 | -73.7 | -70.6 | ±3.0 | -67.8 | -73.4 | -70.6 | ±2.8 |
| ⑬ | -67.2 | -71.9 | -69.5 | ±2.4 | -67.2 | -71.8 | -69.5 | ±2.3 |
| ⑭ | -68.6 | -74.6 | -71.6 | ±3.0 | -68.7 | -74.7 | -71.7 | ±3.0 |
| ⑮ | -68.5 | -73.4 | -71.0 | ±2.4 | -68.5 | -73.1 | -70.8 | ±2.3 |
| Ave. | | | -69.5 | | | | -69.5 | |

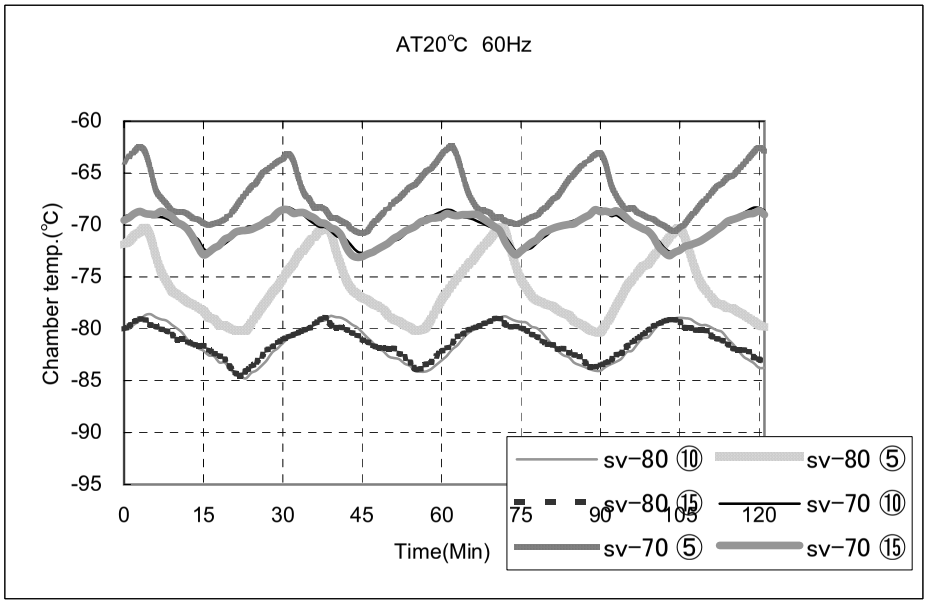
Amount of power consumption

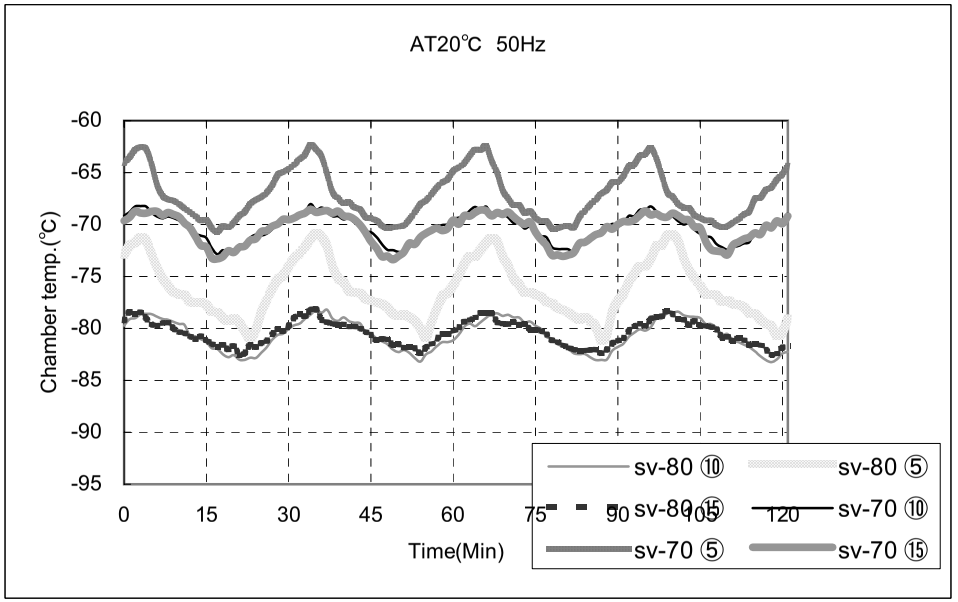
| SV | -70℃ | |
|---|---|---|
| AT | 20℃ | |
| Power source | 100V50Hz | 100V60Hz |
| kWh/day | 9.7 | 9.1 |

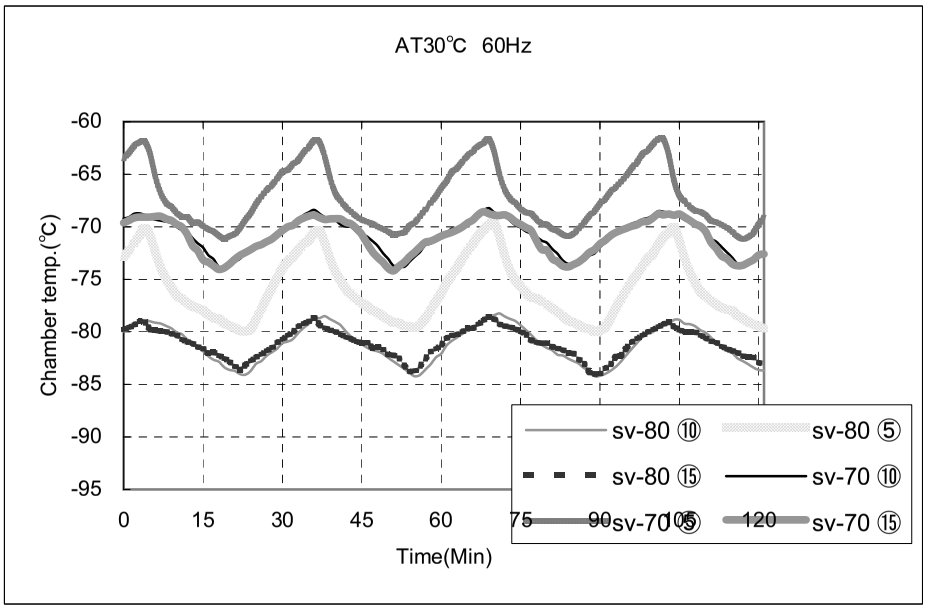
| | SV-70℃ AT:30℃ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100V50Hz | | | | 100V60Hz | | | |
| | Max | Min | Center | Variation | Max | Min | Center | Variation |
| ① | -62.9 | -71.7 | -67.3 | ±4.4 | -63.0 | -71.9 | -67.4 | ±4.5 |
| ② | -63.3 | -72.5 | -67.9 | ±4.6 | -63.4 | -72.5 | -67.9 | ±4.6 |
| ③ | -62.9 | -71.9 | -67.4 | ±4.5 | -63.0 | -72.2 | -67.6 | ±4.6 |
| ④ | -62.9 | -71.9 | -67.4 | ±4.5 | -62.9 | -72.0 | -67.4 | ±4.6 |
| ⑤ | -61.6 | -71.0 | -66.3 | ±4.7 | -61.7 | -71.1 | -66.4 | ±4.7 |
| ⑥ | -67.4 | -73.5 | -70.4 | ±3.1 | -67.3 | -73.3 | -70.3 | ±3.0 |
| ⑦ | -67.9 | -73.7 | -70.8 | ±2.9 | -68.2 | -74.0 | -71.1 | ±2.9 |
| ⑧ | -67.5 | -72.9 | -70.2 | ±2.7 | -67.9 | -73.3 | -70.6 | ±2.7 |
| ⑨ | -66.8 | -73.2 | -70.0 | ±3.2 | -67.1 | -73.0 | -70.0 | ±3.0 |
| ⑩ | -68.2 | -73.6 | -70.9 | ±2.7 | -68.2 | -73.9 | -71.1 | ±2.9 |
| ⑪ | -68.7 | -76.0 | -72.3 | ±3.6 | -69.0 | -76.0 | -72.5 | ±3.5 |
| ⑫ | -67.6 | -74.1 | -70.9 | ±3.2 | -67.7 | -74.3 | -71.0 | ±3.3 |
| ⑬ | -67.1 | -72.5 | -69.8 | ±2.7 | -67.1 | -72.4 | -69.8 | ±2.7 |
| ⑭ | -68.6 | -75.7 | -72.1 | ±3.5 | -68.8 | -75.8 | -72.3 | ±3.5 |
| ⑮ | -68.5 | -74.0 | -71.3 | ±2.7 | -68.6 | -74.2 | -71.4 | ±2.8 |
| Ave. | | | -69.7 | | | | -69.8 | |

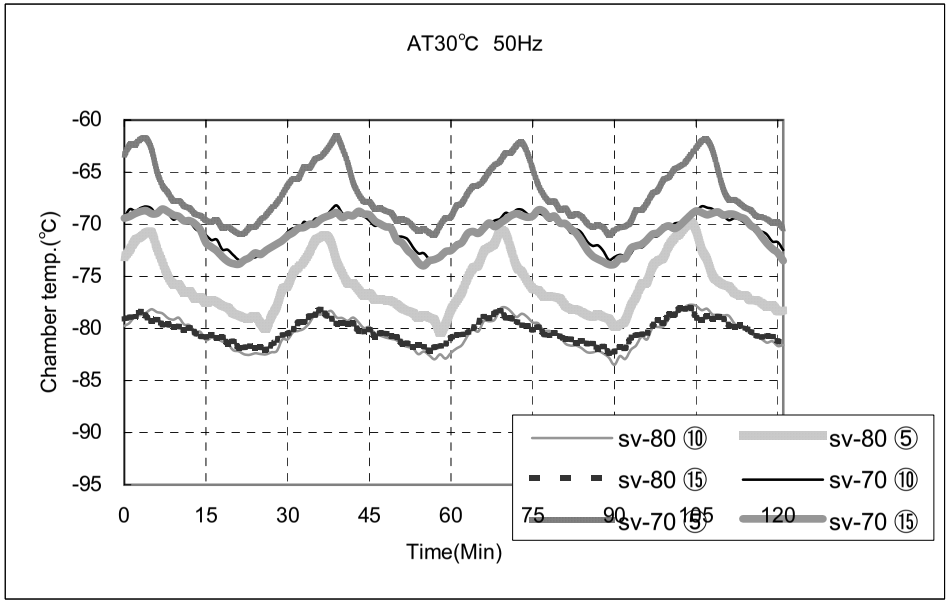
Amount of power consumption

| SV | -70℃ | |
|---|---|---|
| AT | 30℃ | |
| Power source | 100V50Hz | 100V60Hz |
| kWh/day | 10.2 | 9.9 |


AT20℃ 60Hz
Chamber temp.(℃)
-60
-65
-70
-75
-80
-85
-90
-95
0
15
30
45
60
75
90
105
120
Time(Min)
sv-80 ⑩
sv-80 ⑤
sv-80 ⑮
sv-70 ⑩
sv-70 ⑤
sv-70 ⑮


AT20℃ 50Hz
Chamber temp.(℃)
-60
-65
-70
-75
-80
-85
-90
-95
0
15
30
45
60
75
90
105
120
Time(Min)
sv-80 ⑩
sv-80 ⑤
sv-80 ⑮
sv-70 ⑩
sv-70 ⑤
sv-70 ⑮


AT30℃ 60Hz
Chamber temp.(℃)
-60
-65
-70
-75
-80
-85
-90
-95
0
15
30
45
60
75
90
105
120
Time(Min)
sv-80 ⑩
sv-80 ⑤
sv-80 ⑮
sv-70 ⑩
sv-70 ⑤
sv-70 ⑮


AT30℃ 50Hz
Chamber temp.(℃)
-60
-65
-70
-75
-80
-85
-90
-95
0
15
30
45
60
75
90
105
120
Time(Min)
sv-80 ⑩
sv-80 ⑤
sv-80 ⑮
sv-70 ⑩
sv-70 ⑤
sv-70 ⑮